

## REMARKS

Applicants have studied the Office Action dated Januaryb 13, 2005. No new matter has been added. It is submitted that the application is in condition for allowance. By virtue of this amendment, claims 1-16 and 19-20 are pending. Claims 19-20 have been added. Reconsideration and further examination of the pending claims in view of the above amendments and the following remarks is respectfully requested. In the Office Action, the Examiner:

- 1) Acknowledged the correction to the typographical error of FIG. 9;
- 2) Acknowledged the previous arguments regarding allocation sites and maintains the objection to the drawing because the identification of one or more allocation sites is not shown in the drawings;
- 3) Pointed out that claims 8 and 9 are identical to claims 1 and 2;
- 4) Objected to the drawings under 37 CFR 1.83(a) for failure to show the "*the call graph representation includes a corresponding node*", "*method M*", "*single body B*", "*methods M', M*", "*allocation sites*", and "*types of objects*"; and
- 5) Rejected claims 1-16 under 35 U.S.C. §112, second paragraph for being indefinite.

### Examiner Interview

The Applicants wish to thank Examiner Le for the interview on Monday, April 11, 2005. The Applicants' representative Jon Gibbons, along with inventor Frank Tip, participated in the telephone call. A draft of an amendment was provided to aid the discussion.

The first topic of discussion was the pseudo code included in the specification as originally filed and the requirements under 37 CFR 1.83(a) in light of 37 CFR 1.96(b) as cited in MPEP 608.05(b). Agreement was reached that if each line pseudo was cited to support the following "*the call graph representation includes a corresponding node*", "*method M*", "*single body B*", "*methods M', M*", "*allocation sites*", and "*types of objects*", this would satisfy the requirements and the Objection to the Drawings under 37 CFR 1.83(a) for failure would be withdrawn.

Further the claim revisions to help clarify the 35 U.S.C. §112, second paragraph, were discussed. To begin, the Examiner asked how the present invention is different than the prior art. The present invention is an improvement of the propagation-based call graph construction algorithms. Call graph algorithms differ primarily in the number of sets that are used to approximate run-time values of expressions. In practice, algorithms such as RTA that use a single set for the whole program scale well. Further, the scalability of algorithms, such as 0-CFA, that use one set per expression is not certain. The present invention describes a novel algorithm inbetween the design space of RTA and 0-CFA. The present invention improves on the prior art by providing more precision than the RTA algorithm while maintaining acceptable performance. The present invention is distinguished from the prior art by constructing a set of types  $S_M$  for each method M and, when a method M directly calls another method M', performing a reciprocal propagation between the associated sets  $S_M$  and  $S_{M'}$ , and, when a method M virtually calls another method M", performing a reciprocal propagation between the associated sets  $S_M$  and  $S_{M''}$ .

The Examiner asked that an IDS be submitted referencing the inventors' own publication of "*Frank Tip and Jens Palsberg, Scalable propagation-based call graph construction algorithms, In Proceedings of the Fifteenth Annual Conference on Object-Oriented Programming Systems, Languages, and Applications (OOPSLA'00), (Minneapolis, MN, October 15-19, 2000), pp. 281-293. Appeared in ACM SIGPLAN Notices 35(10)*" which is submitted with this response.

Next discussed was the Examiner's comment regarding the claim limitation of "zero or more" is interpreted to mean zero. The Applicants agree with the Examiner's interpretation that in the broadest interpretation these elements of "zero or more fields", "zero or more edges", and "zero or more types" are not present in the claims. In response, the Applicants have amended the independent claims to recite:

wherein the program P contains zero or more fields  $F_F$  and at least two methods  $M_M$

[...]

constructing for each method  $M$  in  $M_M$ , a set of types  $S_M$  of objects which occur therein;

constructing for each field  $F$  in  $F_F$ , a set of types  $S_F$  of objects stored therein;

The terms zero or more fields  $F$  and zero or more edges even in the case of "zero" along with the complete reading of all the elements of the independent claims 1, 8, and 10 distinguish the present invention from over the prior art because for programs that contain at least two methods  $M$  and  $M'$ , two sets of types  $S_M$  and  $S_{M'}$  are constructed, and if method  $M$  calls method  $M'$ , a reciprocal propagation of types between the sets of types  $S_M$  and  $S_{M'}$  is performed along with a reciprocal propagation between the associated sets  $S_M$  and  $S_{M''}$  when a method  $M$  virtually calls another method  $M''$ .

Next the Examiner's questions regarding "*how method M is related to methods M' and methods M''*" and "*how each method plays a role in the construction of the call graph*" and "*how an object in a field is related to an object in a method and what role each object plays in the claimed step for constructing the call graph*". Turning to the independent claim 1, as amended, constructing a set of types occurring within a method (as opposed to constructing a call graph). The relationship between *method M is related to methods M' and methods M''* and how each method plays a role in the construction of a set of types is set forth in the independent claims 1, 8 and 9 as amended as follows:

determining a set of methods M' that are directly called within the body B of each method M and propagating types from a set of types S<sub>M'</sub> to the set of types S<sub>M</sub> and from the set of types S<sub>M</sub> to the set of types S<sub>M'</sub>;

determining a set of methods M'' that are virtually called within the body B of each method M and propagating types from a set of types S<sub>M''</sub> to the set of types S<sub>M</sub> and from the set of types S<sub>M</sub> to the set of types S<sub>M''</sub>;

Further, the Examiner states it is not clear in claims 1, 8, and 10 “*how an object in a field is related to an object in a method and what role each object plays in the claimed step for constructing the call graph.*” As recited in amended independent claim 1 inter alia (claims 8 and 10 recite similar limitations)

determining a set of fields F that are  
read in the body B of each method M, and propagating types from the set  
of types S<sub>F</sub> to the set of types S<sub>M</sub>; and  
written in the body B of each method M, and propagating types from the  
set of types S<sub>M</sub> to the set of types S<sub>F</sub>.

The Applicants have amended independent claim 1 to clarify constructing a set of types occurring within a method (as opposed to constructing a call graph). The relationship between *how an object in a field is related to an object in a method and what role each object plays in the claimed step for constructing the set of types* is set forth in the independent claims as amended.

The Examiner’s insights and explanations of her interpretation were most helpful to further prosecution of the present invention.

Pointed out that claims 8 and 9 are identical to claims 1 and 2

As noted above, the Examiner pointed out that claims 8 and 9 are identical to claims 1 and 2. Independent claim 8 has been amended to recite a limitation which is different than independent claim 1. Since claim 9 is dependent from independent claim 8, and dependent claims contain all the limitations of base claims, claim 9 also is different than claims 1 and 2.

Objection to The Drawings Under 37 CFR 1.83(a)

As noted above, the Examiner objected to the drawings under 37 CFR 1.83(a) for failure to show “*the call graph representation includes a corresponding node*”, “*method M*”,

“single body B”, “methods  $M$ ,  $M'$ ”, “allocation sites”, and “types of objects”. A pseudo code listing which were submitted as part of the specification, rather than a drawing, which is consistent with 37 CFR 1.96(b) as cited in MPEP 608.05(b), where a computer program listing may be filed as either part of the drawings or part of the specification.

Specifically, in the specification as originally filed:

- “*the call graph representation includes a corresponding node*” is found on page 29 lines 21-23, page 30, lines 8-21;
- “*method M*” is found on page 29 lines 10-11 and 25-30, page 30, lines 8-21;
- “*single body B*” is found on page 32 lines 1-25 as the method’s body and page 23, line 2;
- “*methods  $M$ ,  $M'$* ” is found on page 34 lines 7-30;
- “*allocation sites*” is found on page 32 lines 2-25;
- “*types of objects*” is not used in the claims. If instead the Examiner meant to point out “a set of types  $S_M$  of objects is determined that may occur in method  $M$ ”, this can be found on page 8, lines 20-22. Similarly, “a set of types  $S_F$  of objects is determined that may be stored in field  $F$ ”, can be found on page 8, lines 22-25.

It is submitted that the present response overcomes this rejection of the drawings.

#### Rejection Under 35 U.S.C. §112, Second Paragraph

As noted above, the Examiner rejected claims 1-16 under 35 U.S.C. §112, second paragraph for being indefinite. Specifically, the Examiner states it is not clear in claims 1, 8, and 10 “*how method M is related to methods  $M'$  and methods  $M''$  and how each method plays a role in the construction of the call graph.*” As recited in claim 1 *inter alia* (claims 8 and 10 recite similar limitations).

determining a set of methods  $M'$  that are directly called within the body B of each method M and propagating types from a set of types  $S_{M'}$  to the set of types  $S_M$  and from of the set of types  $S_M$  to the set of types  $S_{M'}$ ;

determining a set of methods  $M''$  that are virtually called within the body B of each method M and propagating types from a set of types  $S_{M''}$  to the set of types  $S_M$

and from of the set of types  $S_M$  to the set of types  $S_{M''}$ ;

The Applicants have amended independent claim 1 to clarify constructing a set of types occurring within a method (as opposed to constructing a call graph). The relationship between *method M is related to methods M' and methods M''* and how each method plays a role in the construction of a set of types is set forth in the independent claims as amended. Support for this amendment is found in the specification form pages 29-26. No new matter has been added.

Further, the Examiner states it is not clear in claims 1, 8, and 10 “*how an object in a field is related to an object in a method and what role each object plays in the claimed step for constructing the call graph.*” As recited in amended independent claim 1 inter alia (claims 8 and 10 recite similar limitations)

determining a set of fields F that are

read in the body B of each method M, and propagating types from the set of types  $S_F$  to the set of types  $S_M$ ; and  
written in the body B of each method M, and propagating types from the set of types  $S_M$  to the set of types  $S_F$ .

The Applicants have amended independent claim 1 to clarify constructing a set of types occurring within a method (as opposed to constructing a call graph). The relationship between *how an object in a field is related to an object in a method and what role each object plays in the claimed step for constructing the set of types* is set forth in the independent claims as amended. Support for this amendment is found in the specification form pages 29-26. No new matter has been added. The Applicants respectfully submit that the Examiner's rejection under 35 U.S.C. §112, second paragraph for being indefinite has been respectfully over come and should be withdrawn.

Still further, the Examiner states “*at claims 2, 9, what is T is and what does “each*

*allocation type T: include?* “ Claims 2 and 9 have been amended to clarify determining the set of all types T that are allocated in the body of method M, and adding each element of the set of all types T to the set of types S<sub>M</sub>.

The Applicants have amended claims 2 and 9 to clarify constructing a set of types occurring within a method (as opposed to constructing a call graph). The relationship between *what is T is and what does “each allocation type T: include for constructing the set of types* is set forth in the claims 2 and 9 as amended. Support for this amendment is found in the specification form pages 29-26. No new matter has been added. The Applicants respectfully submit that the Examiner’s rejection under 35 U.S.C. §112, second paragraph for being indefinite has been respectfully overcome and should be withdrawn.

Regarding claims 6, 7, 15, and 16, the Examiner states “*the call graph computed above*” lack antecedent basis, the Applicants have amended claims 6, 7, 15, and 16 to clarify the “using the call graph computed above, as previously constructed, [...]” to properly refer to the call graph. No new matter has been added. The Applicant’s submit that the Examiner rejection of claims 6, 7, 15, and 16 for the lack of antecedent basis has been overcome and should be withdrawn.

Applicants respectfully submitted that the Examiner’s rejection under 35 U.S.C. § 112, second paragraph has been overcome and the Applicants submit that this application is in a condition for allowance, which allowance is requested.

## CONCLUSIONS

The remaining cited references have been reviewed and are not believed to effect the patentability of the claims as previously amended.

In light of the Office Action, Applicants believe these amendments serve a useful

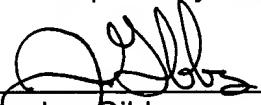
clarification purpose, and are desirable for clarification purposes, independent of patentability. Accordingly, Applicants respectfully submit that the claim amendments do not limit the range of any permissible equivalents.

Applicants acknowledge the continuing duty of candor and good faith to the disclosure of information known to be material to the examination of this application. In accordance with 37 CFR § 1.56, all such information is dutifully made of record. The foreseeable equivalents of any territory surrendered by amendment is limited to the territory taught by the information of record. No other territory afforded by the doctrine of equivalents is knowingly surrendered and everything else is unforeseeable at the time of this amendment by the Applicants and their attorneys.

Applicants respectfully submit that all of the grounds for rejection stated in the Examiner's Office Action have been overcome, and that all claims in the application are allowable. No new matter has been added. It is believed that the application is now in condition for allowance, which allowance is respectfully requested.

**PLEASE**, if for any reason the Examiner finds the application other than in condition for allowance, the Examiner is invited to call either of the undersigned attorneys at (561) 989-9811 should the Examiner believe a telephone interview would advance the prosecution of the application.

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Respectfully submitted,  
By:   
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Jon Gibbons  
Registration No. 37,333  
Attorney for Applicants

FLEIT, KAIN, GIBBONS,  
GUTMAN, BONGINI & BIANCO P.L.  
One Boca Commerce Center, Suite 111  
551 Northwest 77th Street  
Boca Raton, FL 33487  
Tel. (561) 989-9811  
Fax (561) 989-9812